UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON D. C.

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Based on Field Clinic Data

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A METHOD FOR JUDGING QUALITY OF PLANTING SITES FOR BLACK LOCUST, BASED ON FIELD CLINIC DATA[1]

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INTRODUCTION AND RESUME

Variable growth of black locust in Soil Conservation Service field plantings has emphasized the need for information concerning the factors influencing this variability in order that future planting sites may be wisely chosen and that measures necessary for improvement of sites already planted may be determined.

A clinical survey consisting of observations by representatives of the Operations and Research Divisions of the Soil Conservation Service and Division of Forest Pathology, Bureau of Plant Industry, was made September 25 to October 13, 1939 in an area extending from High Point, North Carolina, to Port Gibson, Mississippi.

Through early discussions of field conditions encountered, the difficulty in determining exact causes for the variability in locust height growth was realized. However, it became increasingly obvious that a study of measurements of physical things accompanying variable locust growth might result in the association of certain of these facts with good and certain others with poor black locust growth response. It was hoped thereby to provide at least a relative

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[1] Agencies cooperating in the Black Locust Field Clinic were:

Forestry, Hillculture, Conservation Experiment Stations, and Physical Survey Divisions of the Soil Conservation Service, and the Division of Forest Pathology, Bureau of Plant Industry.

A list of the individuals taking part in the collection of data is appended to this report.

The writer wishes to acknowledge the helpful guidance and comments made on this report by A. E. Fivaz, H. M. Sebring, D. E. Lauderburn, T. C. Peele, and Carl Hartley. Appreciation is also expressed for the suggestions given by J. G. Osborne, E. B. Lambert, and A. E. Brandt. The detailed compilation of the data was greatly facilitated by the valuable assistance of Mr. D. C. Stout whose help in this work was made possible through funds of the Works Progress Administration.

means of judging site quality, even though the exact reasons why these associations existed might not be easily explained.

With this in mind an attempt was made to associate the first data collected with locust height growth. On this basis it became evident that soil profile measures were a valuable means of identifying poor sites having inadequate drainage and good sites consisting of well drained colluvial soils. Of greater importance, however, was the realization that in between these extremes, which were in the minority, there existed a wide range of soil texture profiles capable of supporting either good or poor locust growth. This fact established the necessity for measurements of other things as well as soil profile. It was then decided to obtain more detailed measurements of the amounts of litter cover, the amounts of plant cover and the species composition. This plan was followed in the Coastal Plain area and the samples collected were used as the basis for a more detailed analysis.

The association of the various field measurements with locust height growth and the development of a method for reducing their complexity to a system in which they can be taken into account in the choice of planting sites, are described in this report. It is recognized that the method now needs to be checked by accumulating further data. In this manner one may also test the validity of the following tendencies indicated by this study:

1. That soil profiles are the most satisfactory means of identifying spots having very poor internal drainage. Such spots may be recognized by the presence of a high water table, or a gray-blue mottled subsoil, or a very compact, hard-dry subsoil.

2. That under all other conditions it is best to utilize measurements of several factors in addition to soil texture profiles when determining site quality.

3. That the other measurable things which are most likely to give a positive indication of locust site quality are:

    a. Species composition of the vegetative cover.
    b. Amount of the vegetative cover.
    c. Amount of the litter cover.
    d. Degree of sheet erosion and presence of active erosion.

4. That by the method described in this report it is possible to obtain a numerical rating in terms of locust height growth for the factors listed under a, b, c, and d.

METHODS

Black locust plantings to be visited by members of the clinic were selected by H. M. Sebring, Chief of the Regional Forestry Division, Region 2, from a list submitted by the area foresters. A tentative sampling method and data sheets had been prepared by T. J. Grant and J. C. Ready, on the basis of experience obtained in a study of conditions at the Arlington Experiment Farm, Virginia, and vicinity. After making observations on numerous plantings in the Piedmont area, a preliminary discussion led to some modification in the taking of the data. The essential features of the method finally adopted and used throughout the Coastal Plain and loessial soil provinces are as follows:

1. Separation of gully and old field plantings with particular attention to the latter.

2. Selection within each plantation of representative areas of good and poor locust growth.

3. Taking of soil borings in each of these representative areas and recording in each the soil series and texture profile.

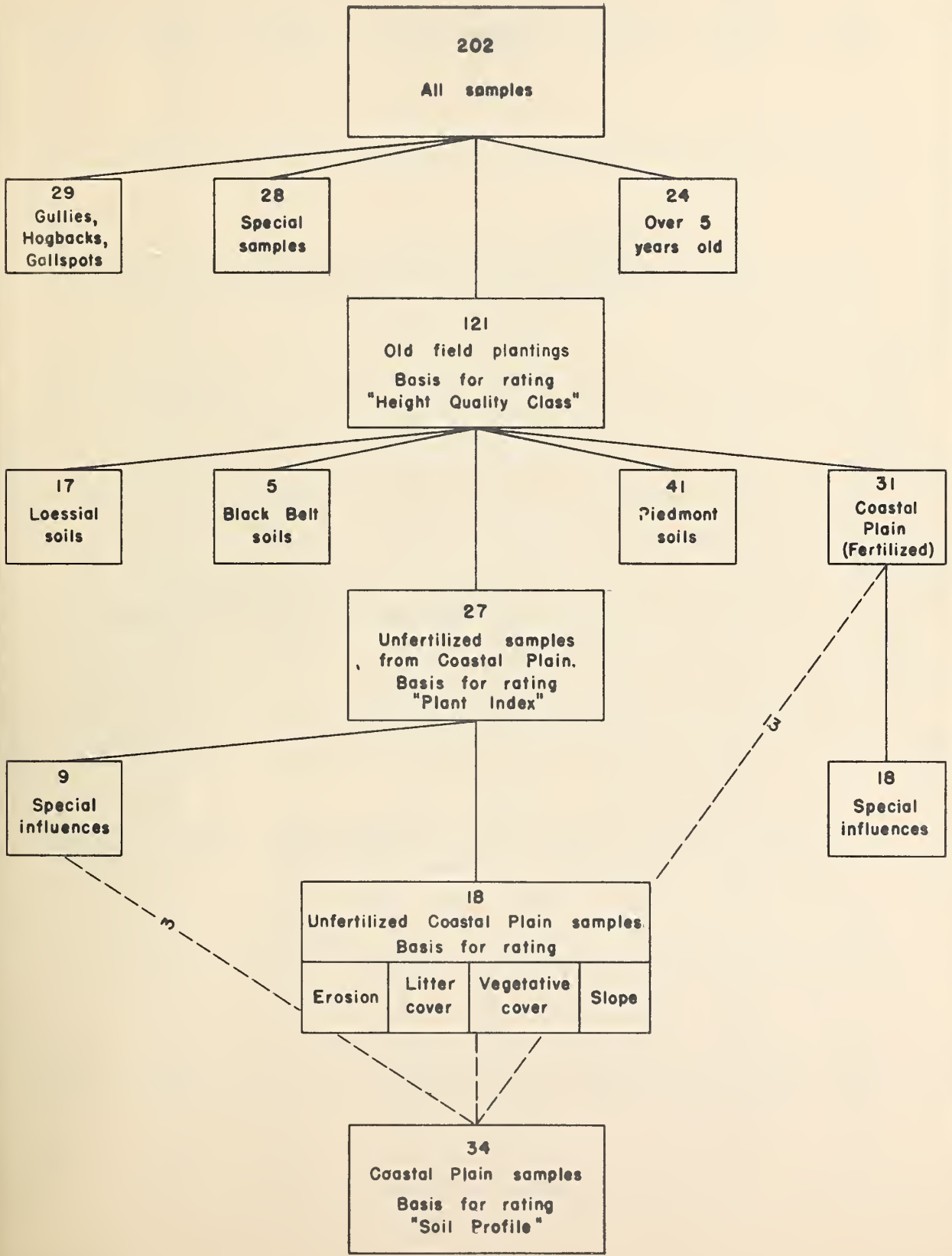
4. Measurement of the heights of 4 trees adjacent to the soil boring, and determination of their average height.

5. Other records taken in the immediate vicinity of the soil boring and adjacent trees were: location, age, type of planting, tree spacing, site treatment, cultivation, fertilization, pruning, percent of slope, degree of erosion, amount of exposed soil, litter and vegetative cover, list of plant species present and notes on any special influences such as hog grazing, rodent injury, fire, etc.

ANALYSIS OF DATA

Analysis of the data from 202 samples necessitated segregation of these into groups. The divisions made are shown in Figure 1. A majority (121) of the samples were representative of 2 to 5 year plantings on old fields. With these samples as a basis, locust height quality classes were established (Fig. 2) in the following manner: The data of height over age were plotted. The height being the average height of four trees adjacent to the soil boring and the age being the number of growing seasons since the plantation was started. Curves for the average height over age and standard

Fig. 1.— Segregation of the 202 Black Locust Clinic Samples into Groups



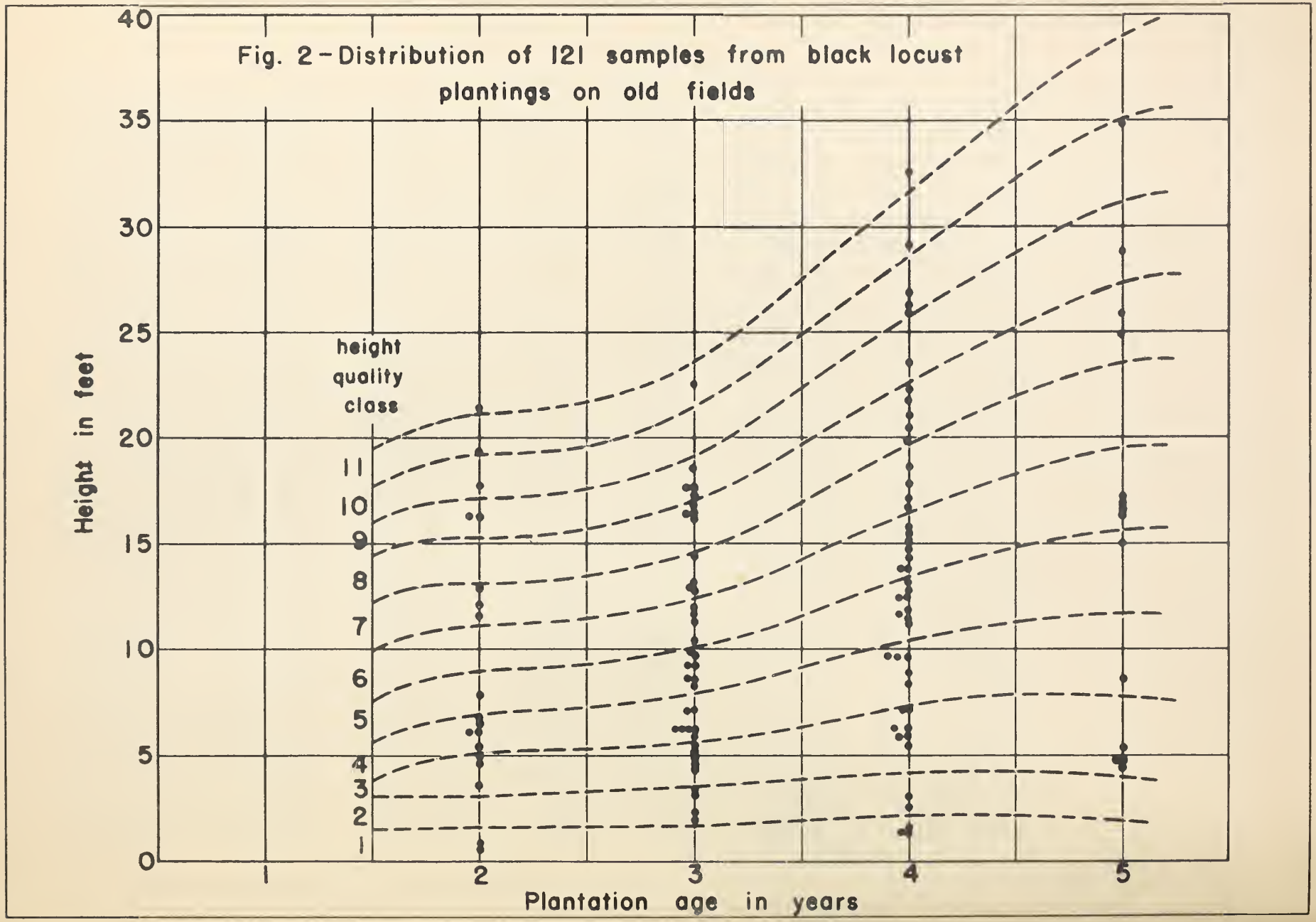


Fig. 2 - Distribution of 121 samples from black locust plantings on old fields
Height in feet
0
5
10
15
20
25
30
35
40
height quality class
11
10
9
8
7
6
5
4
3
2
1
1
2
3
4
5
Plantation age in years

deviation over age were established. A range of three feet at age 4 years was selected as the width of a quality class. Three feet were seen to be 0.4 standard deviation at age 4 years, then bands of curves 0.4 standard deviation in width were drawn on the graph of height over age with the average curve forming the upper margin of quality class 5 and the lower margin of quality class 6. In this way, 11 quality classes were established taking age into consideration and ranging from the shortest tree heights in class one to the tallest in class 11. In order to continue class 1 into the older age classes it was found desirable to divide the distance between the lower boundary of class 3 and the zero line into two equal parts.

It should be kept in mind that, in this scale, class 5 is slightly below the average locust height growth obtained in this study. Thus, for purposes of general consideration, class 5 represents intermediate locust growth, while classes 1 to 4 represent relatively poor, and classes 6 through 11 good locust height growth.

The division of the samples into 11 locust height quality classes formed a basic scale against which the various quantities of each factor to be considered could be placed and their values determined in terms of height quality classes.

From preliminary analysis and knowledge of the data it became evident that there were certain general tendencies, but that it was necessary to further segregate the 121 samples into divisions in which, at least, some of the factors were similar.

Thus, as shown in Figure 1, the samples were divided into soil provinces and the data from Coastal Plain soils selected for more detailed study. This was done because of the number of samples available, and because these samples were taken according to the more refined method of sampling previously mentioned.

Distribution of the samples collected on Coastal Plain soils is shown in Table 1 according to soil series and whether the spots sampled were fertilized or unfertilized. There were not enough samples or sufficient height quality class range within any one soil series to justify detailed analysis on this basis. Therefore, the Coastal Plain samples were considered as a group, but the distinction between fertilized and unfertilized samples maintained.

TABLE 1. – DISTRIBUTION OF 58 SAMPLES COLLECTED IN THE COASTAL PLAIN SOIL PROVINCE, ACCORDING TO THE SOIL SERIES AND FERTILIZER TREATMENT OF THE SAMPLES IN EACH LOCUST HEIGHT QUALITY CLASS.

Locust height quality class	Soil Series									Total number of samples for all soil series, according to treatment		
	Colluvial	Orangeburg	Ruston	Cuthbert	Norfolk	Bowie	Akron	Pheba	Sawyer			
	A* B* C*	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A	B	C
11	1	1			1					0	3	0
10	1	1 1								1	2	0
9	1 1		1							1	2	0
8	1 1	1		2						3	2	0
7	1	1	1 2	1						3	1	2
6	2	1	3 1 2			1				5	2	3
5	1	2 1	1 2							3	2	2
4	1	2	1 1 1		1					1	5	1
3			2	5	1		1	1		7	2	1
2			1	1						2	0	0
1			1						1	1	1	0
Sub-totals	4 7 0	4 7 0	10 3 7	9 0 0	0 3 0	0 0 1	0 1 0	0 0 1	0 1 0	27	22	9
Totals	11	11	20	9	3	1	1	1	1		58	

A – Unfertilized samples, B – Samples having fertilizer added, C – Samples having manure and/or lime added.

DETERMINATION OF VARIOUS FACTOR RATINGS BASED ON LOCUST HEIGHT QUALITY CLASSES

A study was made of the relation between locust height growth and associated plant species. All plant species recorded on each sample were listed. Many of the species occurred in only one or two samples, and therefore were not deemed useful in this analysis. After study of the data, an arbitrary limit of 4 was established as a minimum number of occurrences necessary for consideration of a plant species as a possible indicator of locust height growth. This reduced the number of plant species considered to 15. The distribution by locust height quality class and fertilizer treatments of samples containing these species is shown in Table 2. The calculated locust height quality class rating for each species was obtained as a weighted class average. Comparison of the figures obtained from fertilized and unfertilized samples led to acceptance of the ratings based on the unfertilized samples, except for one plant (cockleburr). Each of the 15 species has, therefore, a definite calculated value in terms of locust height growth. There would naturally be some doubt as to how accurate a single plant would be as an index of locust height growth, and it was essential to determine how many plants were necessary to obtain a relatively reliable index. With this in mind the calculated species values were applied to each sample determined. The number of indicator plants present in different samples varied and results of the calculation for each sample are shown in Table 3.

Study of these figures showed that in the unfertilized samples the values obtained from three or more plant species afforded a relatively reliable index of good and poor locust height quality class. That is, samples above locust height quality class 5 have a plant index greater than 5, while samples below class 5 have a plant index less than 5. In the fertilized samples, however, there were several which did not follow this tendency. It seemed evident then that in some samples there were factors having greater influence than plant species. In cases where the plant index figure was appreciably lower than the actual locust height class value, it seemed possible that the addition of fertilizer had increased the growth of locust, but had not altered the associated plant species. In cases where the plant index was appreciably higher than the actual locust height class, a plausible explanation was found when these samples were segregated and the presence of poor drainage conditions noted.

On the basis of this knowledge, it seemed desirable to again divide the samples and sort out those where special influences such as fire, hog grazing, or poor drainage occurred, so that the basic ratings for each factor studied would not be influenced by special conditions. When this was done it left only 18 unfertilized samples as a basis for rating the factors. Although it would be very

TABLE 2. NUMBER OF OCCURRENCES OF VARIOUS PLANT SPECIES IN 58 COASTAL PLAIN SAMPLES, DISTRIBUTED ACCORDING TO LOCUST HEIGHT QUALITY CLASS AND FERTILIZER TREATMENT OF SAMPLES.

Height quality class	Plants associated with good locust growth							Association indeterminate:		Plants associated with poor locust growth						
	Black-berry	Panic grass	Ber-muda	Ager-atum	Golden-rod	Rag-weed	Cock-lebur	Dog-fennel	Broom-sedge	Rabbit tobacco	Beggar-weed	Am. Les-pedeza	Poor Joe	Wild lettuce	Bitter weed	
	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C	A-B-C
11	-2-			-1-		-1-	-1-	-3-	-3-					-1-		
10	1+1-		-1-	-1-		-2-	1+	-1-	-1-			-1-		-1-		
9	1+		1+	-1-			-1-	-1-	-2-	-1-			-1-	-1-		
8	3+		1+				-1-	1+2-	2+2-		-1-					
7	1+1-	2+	2+		1+			-1	2+1-2				-1			-1-1
6	3+1-1	2+	1+	2+ -2	2+	3+2-2	-1-	2+2-	3+2-2		1+	-1				
5	-1		1+		1+	2+2-1		1+1-1	3+1-1	1+	1+	2+1-	1+ -2	1+		
4			+1-			-1-1-		+2-	1+5-1	1+		-2-		1+2-		
3			1+			-1-	-1-	2+2-1	6+1-	1+	2+	3+	1+1-1	2+	1+	
2									2+		1+	2+	1+			
1						-1-		-1-	1+1-				1+1-		-1-	
Totals	9- 5- 2	4- 0- 0	7- 2- 0	2- 3- 2	4- 0- 0	5- 10- 4	1- 5- 0	6- 15- 3	20- 19- 6	3- 1- 0	5- 1- 0	7- 4- 1	4- 3- 4	4- 5- 0	1- 2- 1	
Weighted class average:	7.5- 9.0- 5.5	6.5- 0- 0	6.4- 7.0- 0	6.0- 10.0- 6.0	6.0- 0- 0	5.6- 6.1- 5.2	10.0- 7.4- 0	5.1- 6.6- 5.0	4.5- 6.5- 5.8	4.0- 9.0- 0	3.8- 8.0- 0	3.2- 5.7- 6.0	2.7- 4.3- 5.0	3.7- 7.6- 0	3.0- 4.0- 7.0	
Accredited indicator rating:	7.5	6.5	6.4	6.0	6.0	5.6	7.4	5.1	4.5	4.0	3.8	3.2	2.7	3.7	3.0	

A - Unfertilized samples. B - Fertilized. C - Manure and/or lime added.

TABLE 3. PLANT INDEX RATINGS FOR EACH OF THE 58 COASTAL PLAIN SAMPLES SHOWING NUMBER OF SPECIES USED AS THE BASIS FOR EACH RATING

Unfertilized Samples

Sample No.	Locust height quality class	Plant index rating — No. of species rating is based on: 1	2	3	4	5	6	7	8
54A	10	7.5							
52B	9		7.0						
47A	8	7.5							
49A	8			5.7					
61A	8			6.1					
48A	7		6.5						
62A	7					6.2			
39A	7	4.5							
51B	6		6.8						
45C	6	4.5							
52C	6			5.4					
53A	6								5.7
53B	6					6.1			
56B	5			4.7					
50A	5					4.2			
50C	5						4.6		
53C	4			4.1					
51A	3			4.0					
49B	3	2.7							
47B	3		3.9						
46A	3				3.7				
56A	3		4.8						
50B	3				4.8				
53D	3			4.0					
43B	2		3.8						
45B	2				3.6				
61B	1		3.6						

Samples With Fertilizer Added

Sample No.	Locust height quality class	Plant index rating — No. of species rating is based on: 1	2	3	4	5	6
42A	11			4.4			
74A	11				5.7		
34B	11					6.1	
60A	10						5.7
38B	10			4.4			
37A	9				5.7		
63B	9					4.2	
38A	8			4.5			
40A	8			5.7			
73A	7			5.0			
45A	6			5.1			
74B	6					6.1	
34A	5			5.1			
42B	5		4.4				
37B	4			4.3			
34C	4		4.8				
63A	4		4.1				
38C	4			4.4			
40B	4			4.9			
35B	3				5.3		
36A	3			4.4			
35A	1					4.2	

Samples With Manure and Mulch Added

	Sample No.	Locust height quality class	Plant index rating — No. of species rating is based on: 1	2	3	4	5	6	7	8
x	59B	7				3.8				
x	59A	5		3.0						

Samples With Manure and/or Lime Added

	Sample No.	Locust height quality class	Plant index rating — No. of species rating is based on: 1	2	3	4	5	6
x	55B	7	4.5					
⊗	57B	6					5.9	
x	58A	6			4.4			
⊗	57C	6		5.3				
0	62B	5					5.1	
x	55A	4		5.1				
⊗	57A	3		3.9				

LEGEND

x – Manure
0 – Lime
⊗ – Lime and manure

desirable to have a much larger number of samples, it is of considerable interest that certain definite tendencies were established by relating litter cover, vegetative cover, and degree of sheet erosion to locust height quality classes, as shown in Table 4. No evident relationship of locust height quality class and slope could be obtained either from the 18 sample group or from a plotting of all Coastal Plain samples. This negative relationship of slope to locust height quality class helps to strengthen the instances where positive tendencies were secured.

Having taken records of soil texture profile and noted the effects of poor drainage similar to those previously reported (J. T. Auten, Central States Forest Experiment Station Note No. 31, 1936), it seemed desirable to attempt to relate the profiles and subsoil conditions in the Coastal Plain samples to locust height quality classes in a manner similar to the other factors studied. The variability in depth of layers and textures was such that some kind of grouping was necessary. However, in order to obtain a logical basis for this grouping, studies were made of the relation of locust height growth to the following things: depth of soil to compaction, and fertility level of top and subsoil as indicated by results of "Quick" tests of available nitrogen, phosphate, and potassium. (Table 5.)[1]

A preliminary study of the N.P.K. data showed, as was the case in study of each of the other individual factors, that segregation of the samples into comparable groups was necessary in order to obtain any logical relationships. In the upper part of Table 5 is a group of samples having a height class range of 1 to 11. It is evident that those samples below class 5 have a relatively low topsoil fertility level while those above class 5 have a relatively high level of fertility. It is also of some interest that the plant indicator ratings are higher for the samples above class 5 than for those below class 5. The quick tests are of definite value, but interpretation of the results must take into consideration the physical conditions of the soil and eliminate those with very poor internal drainage.

Results of the study of soil conditions indicated that soil profile measures are of definite value; first, in eliminating for locust planting areas where poor drainage occurs, as indicated by the presence of wet, mottled, or very compact subsoil; second, in helping to eliminate excessively drained areas; and third, in recognition of soil texture profiles that do not in themselves limit locust growth, but necessitate measurement of associated conditions in order to interpret their suitability for locust growth.

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[1]Helpful cooperation of Dr. T. C. Peele in running chemical tests on the soil samples is appreciated.

TABLE 4. NUMBER OF OCCURRENCES OF VARYING DEGREES OF LITTER COVER, VEGETATIVE COVER, AND SHEET EROSION DISTRIBUTED ACCORDING TO LOCUST HEIGHT QUALITY CLASSES. (Based on 18 unfertilized Coastal Plain samples having no special influences.1/)

No. of samples	Locust height quality class	Density of litter cover: L	LM	M	MH	H
	11					
	10					
	9					
2	8			1		1
1	7			1		
3	6			2		1
3	5	1	1	1		
1	4	1				
6	3	6				
1	2	1				
1	1	1				
18	Weighted class average	3.0	5.0	6.4	-	7.0

No. of samples	Locust height quality class	Density of vegetative cover: L	LM	M	MH	H
	11					
	10					
	9					
2	8				1	1
1	7					1
3	6				1	2
3	5			1	1	1
1	4				1	
6	3	1	2	1	2	
1	2	1				
1	1	1				
18	Weighted class average	2.0	3.0	4.0	4.8	6.4

No. of samples	Locust height quality class	Degree of erosion: 5	4	3	2	1	+
	11						
	10						
	9						
2	8				1		1
1	7					1	
3	6					1	2
3	5					3	
1	4					1	
6	3			2	2	2	
1	2			1			
1	1		1				
18	Weighted class average	-	1.0	2.6	4.6	4.8	6.6

LEGEND: L - light, LM - light-medium, M - medium, MH - medium heavy, H - heavy.

1/ Such as hog grazing, recent burning or intensive cultivation, terraces affecting drainage, mulches, etc. (See Table 8, Group D.)

TABLE 5 - Results of Nitrogen, Phosphorous, and Potassium "quick" tests in relation to locust height quality class.

Sample Number	Soil Series	Locust Height Quality Class	Top Soil N	Top Soil P	Top Soil K	Subsoil N	Subsoil P	Subsoil K	Plant Indicator Ratings	Treatment
					Unfertilized					
29B	Starr *	11	H	L	H	--			(5.3)	None
47A	Cuthbert	8	VH	M	H	H	H	H	(7.5)	"
48-A	Cuthbert	7	L	H	H	M	H	H	6.5	"
51-B	Colluvial	6	MH	VL	MH	-	-		(6.8)	"
56-B	Ruston	5	VH	VL	H	MH	L	L	4.7	"
56-A	Ruston	3	VL	VL	L	VL	M	L	(4.8)	"
46A	Cuthbert	3	VL	VL	MH	H	MH	M	3.7	"
51A	Cuthbert	3	VL	VL	L	M	H	L	4.0	"
61-B	Ruston	1	L	L	M	-	-		(3.6)	"
					Commercial Fertilizer					
34-B	Norfolk	11	VH	L	H	M	MH	L	6.1	600# - 6 - 8 - 4
60A	Colluvial	10	VH	H	H	-	-		5.7	500# - 4 - 8 - 4
40A	Jamison	8	MH	M	L	L	VL	L	5.7	400# - 4 - 8 - 4
34A	Ruston & Norfolk Alluvial	5	H	VL	M	L	VL	L	5.1	600# - 4 - 8 - 4
40B	Orangeburg	4	L	M	L	VL	MH	L	4.9	400# - 4 - 8 - 4
					Manure					
31B	Appling*	7	H	MH	L	VL	H	L	5.0	Stable Manure
55-B	Ruston	7	VH	L	H	L	H	M	(4.5)	Barnyard Manure
55A	Ruston	4	H	VL	H	H	MH	L	(5.1)	Barnyard Manure (Heavy stand Lesp. sericea)
					Hay Mulch and Manure					
59B	Ruston	7	MH	VL	M	VL	VL	L	3.8	Hay mulch and manure
59A	Ruston	5	M	L	L	-	-		(3.0)	Hay mulch and manure
					Special Group					
45-C	Ruston	6	VL	VL	H	-	-		(4.5)	Burned - Spring of '39
45-B	Ruston	2	VL	VL	M	VL	M	L	(3.6)	Burned - Spring of '39
47-B	Cuthbert	3	MH	VL	H	VH	MH	M	(3.9)	Growth influenced by compaction within 5 inches of surface.
48-B	Cuthbert	2	VL	M	H	L	H	H	(3.8)	

( ) - Based on less than 3 indicator species.

* Indicates Piedmont soils - All others being Coastal Plain.

In order to obtain profiles representative of the extremes in soil conditions, it was necessary to draw on samples from both the fertilized and unfertilized divisions. This was, of course, influenced by judgment, but appeared logical in view of the fact that, for example, poor locust growth occurred on poorly drained soils even where fertilizer had been added. The basis for determining ratings for various soil profiles in relation to locust height quality class on Coastal Plain soils is shown in Table 6.

COMPILATION OF FACTOR RATINGS TO OBTAIN CALCULATED LOCUST HEIGHT QUALITY CLASS FOR EACH SAMPLE

The basic ratings for the individual factors such as soil profile, erosion, litter cover, vegetative cover, and plant index were assembled as shown in table 7. By using this determined scale of ratings for each factor, their values for each sample were listed and totaled. Then division of the totals by 5 (the number of factors listed) resulted in an average or calculated rating of locust height quality class for each sample. The factor values and calculated height quality class ratings are shown in Table 8, in which the samples are grouped as follows:

18 samples - no fertilizer added, no special influences.

11 samples - fertilizer added, no special influence.

6 samples - lime and/or manure added, no special influence.

21 samples - having special influences.

(2 samples - insufficient data to apply ratings.)

Total 58 Coastal Plain samples.

COMPARISON OF CALCULATED WITH ACTUAL LOCUST HEIGHT QUALITY CLASS

Detailed comparison may be made in Table 8 of individual factor values with calculated and actual locust height quality classes. However, it seemed desirable to express graphically some of these comparisons. Thus, Figure 3 shows the comparison of calculated with actual locust height quality class ratings for 18 samples that were not fertilized or subject to special influences. For this group of samples which were the foundation of several factor values, there is essentially a straight line relationship. The calculated class ratings are not exactly the same as the actual, but they are sufficiently close to distinguish between the samples above and below class 5, which is the intermediate locust height growth class. It is evident from the line drawn on Fig. 3, that in the poor classes the actual was less than the calculated, while in the good classes, the actual was usually higher than the calculated height class.

TABLE 6. NUMBER OF OCCURRENCES OF VARIOUS SOIL PROFILES ON 34 COASTAL PLAIN SAMPLES, DISTRIBUTED ACCORDING TO LOCUST HEIGHT QUALITY CLASS AND FERTILIZER TREATMENT.

Number of samples		Locust height quality class	Soil profile																	
			Top-soil; Wet subsoil		Coarse texture; excessive drainage		Top-soil; Mottled subsoil		Subsoil at ground surface		Topsoil 6 in. or less; Subsoil plastic or very compact		Topsoil over 6 inches; Subsoil plastic or very compact		Topsoil 6 in. or less; Subsoil none to moderate compaction		Topsoil over 6 inches; Subsoil none to moderate compaction		Colluvial deposits friable, well drained	
A	B		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	1	11																1		
	1	10																		1
	1	9																		1
3	1	8											2					1	1	
1	1	7															1	1x		
4	2	6															3	2x	1	
3	2	5		1													3	1y		
1	2	4		1		1											1			
7	1	3		1			4				1						2			
1		2					1													
1	1	1		1					1											
		Weighted Class Average		3.2			2.8		1.0		3.0		8.0 1/				5.0	7.1	7.0	9.5
21	13																			

Legend: A–unfertilized; B-fertilizer, manure, or lime added; x-manure only, y-lime only.

1/ The relatively good growth of locust on what would appear to be a poor soil profile is possibly due to the young age of the plantation in which the present growth has not as yet been influenced by the subsoil conditions.

TABLE 7 -- SUMMARY OF FACTOR RATINGS RELATED TO LOCUST HEIGHT QUALITY CLASSES AS ESTABLISHED IN TABLES 2, 4, AND 6.

Density of litter cover					Density of vegetative cover					Degree of erosion					
Light	Light-medium	Medium	Medium-heavy	Heavy	Light	Light-medium	Medium	Medium-heavy	Heavy	5	4	3	2	1	+
3.0	5.0	6.4	-	7.0	2.0	3.0	4.0	4.8	6.4	-	1.0	2.6	4.6	4.8	6.6

Soil profile							
Wet subsoil	Mottled subsoil	Subsoil at surface	6" or less of topsoil over plastic subsoil	More than 6" of topsoil over plastic subsoil	6" or less of topsoil over subsoil with none to moderate compaction	More than 6" of topsoil over subsoil with none to moderate compaction	Well drained friable, colluvial deposits
3.2	2.8	1.0	3.0	8.0	—	5.0	7.0

Basis for plant index1/

Associated with good locust growth		Association indeterminate		Associated with poor locust growth	
Plant species	Rating	Plant species	Rating	Plant species	Rating
Blackberry	7.5	Dog fennel	5.1	Rabbit tobacco	4.0
Panic grass	6.5	Broomsedge	4.5	Beggarweed	3.8
Bermuda	6.4			An. lespedeza	3.2
Goldenrod	6.0			Wild lettuce	3.7
Ageratum	6.0			Bitterweed	3.0
Ragweed	5.6			Poor Joe	2.7
(Cocklebur)	(7.4)				

1/ Plant index - average value of all plant indicators present in each sample.

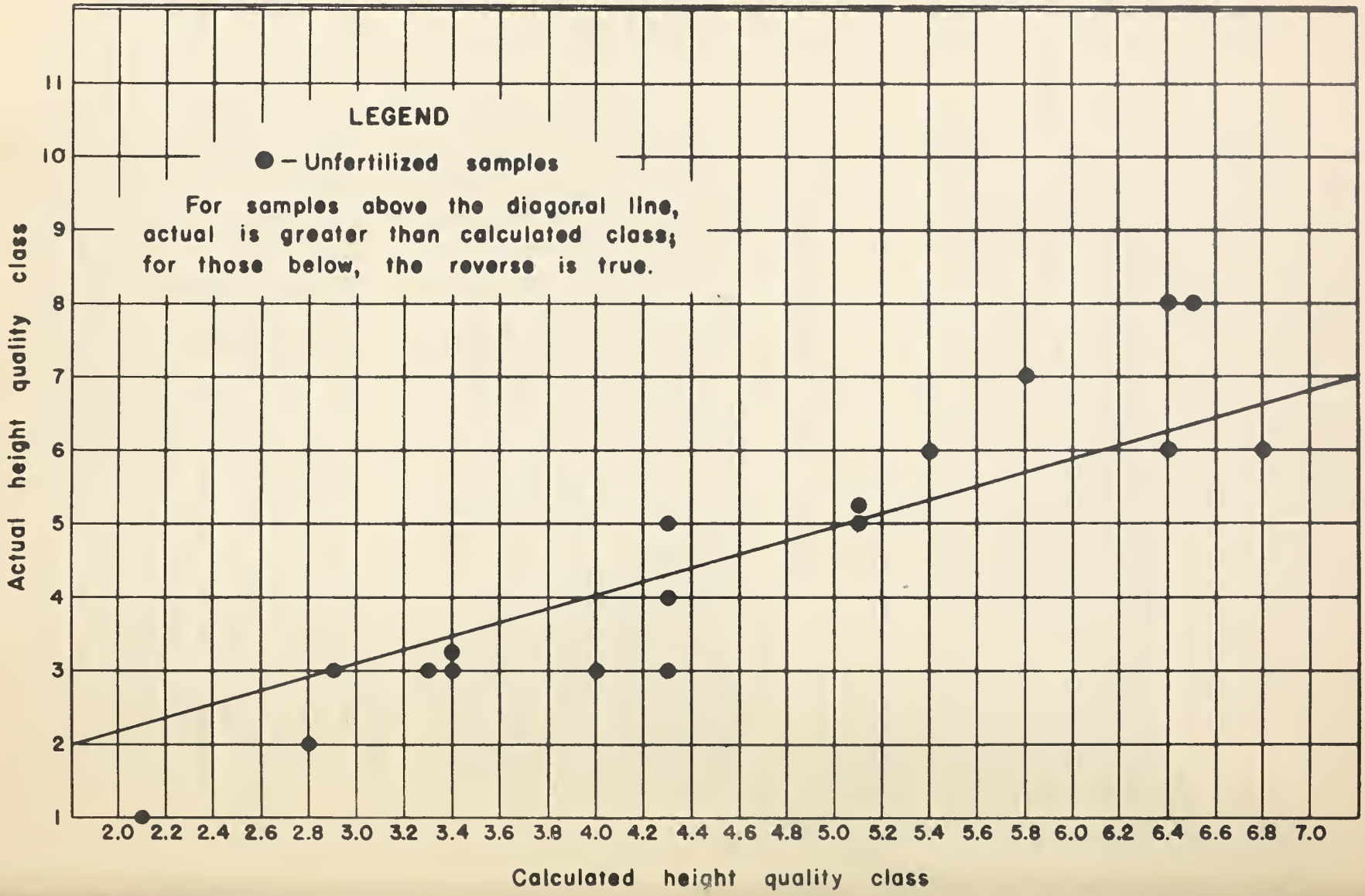
TABLE 8, Continued.

GROUP D. - 21 Samples having Special Influences.

Sample number	Factors Measured (Ratings) Profile	Ero-sion	Litter cover	Vegeta-tive cover	Plant index	Total	Calculated height quality class	Actual height quality class	Special influences affecting factor ratings
42A	5.0	4.6	6.4	3.0	4.4	23.4	4.7	11	On contour, between terraces, 400# Super phosphate, very compact subsoil at 18".
54A	5.0	2.6	7.0	3.0	(7.5)	25.1	5.0	10	Erosion rate seems in error.
63B	5.0	4.8	3.0	2.0	4.2	19.0	3.8	9	300# complete fertilizer, on contour at lower edge of big terrace.
52B	7.0	6.6	3.0	2.0	7.0	25.6	5.1	9	Hog grazing.
49A	8.0	6.6	3.0	4.0	5.7	27.3	5.5	8	1" of "plus" material.
39A	5.0	4.6	3.0	4.0	4.5	21.1	4.2	7	Improved since cultivation this year.
59B	5.0	4.6	3.0	2.0	3.8	18.4	3.7	7	Manure and hay mulch.
73A	7.0	6.6	3.0	2.0	5.0	23.6	4.7	7	400# 8% Phos., hog grazing.
48A	5.0	4.8	3.0	4.0	(6.5)	23.3	4.7	7	Grazed & burned - 1938.
52C	5.0	6.6	3.0	4.0	5.4	24.0	4.8	6	2" of "plus" material.
45A	5.0	4.8	5.0	4.8	5.1	24.7	4.9	6	400# 4-8-4 fertilizer, burned 1939.
45C	5.0	4.8	5.0	4.8	(4.5)	24.1	4.8	6	Burned 1939.
59A	5.0	1.0	3.0	2.0	3.0	14.0	2.8	5	Manure and Hay mulch.
42B	1.0	1.0	3.0	4.0	4.4	13.4	2.7	5	On contour, between terraces, 400# 16% Phos.
34A	5.0	6.6	6.4	6.4	5.1	29.5	5.9	5	600# 6-8-4 fertilizer, but wet subsoil.
55A	5.0	4.8	6.4	6.4	5.1	27.7	5.5	4	Manured, L. sericea planted-competing for moisture?
63A	5.0	4.8	3.0	2.0	4.1	18.9	3.8	4	On contour, between terraces
37B	5.0	6.6	3.0	6.4	4.3	25.3	5.0	4	400# 4-8-4 fertilizer, but overdrained
34C	5.0	6.6	6.4	4.0	4.8	26.8	5.4	4	600# 6-8-4 fertilizer, but wet subsoil
45B	5.0	2.6	3.0	2.0	3.6	16.2	3.2	2	Bare area below terrace, burned 1939
35A	5.0	4.8	3.0	2.0	4.2	19.0	3.8	1	400# 16% Phos. in beds, 200# 16% Phos. each year since, but wet subsoil

( ) - Based on less than 3 plant indicator species.

Fig. 3—Comparison of calculated with actual locust height quality class ratings for 18 samples that were not fertilized or subject to special influences.



With this basic tendency and line established, the addition of all other Coastal Plain sample ratings are of interest. In Figure 4, it can be seen that the fertilized samples without special influences show a definite tendency to be several classes above the calculated locust height quality class. The samples where special influences occurred (indicated by the word notations) also show deviations from the calculated class ratings. For example, 2 samples in actual class 5 have calculated ratings of 2.7 and 2.8, but in these instances one sample received a treatment of hay mulch and manure, while the other was influenced by a terrace and heavy application of phosphate. On the other end of the scale, the actual class rating was in some instances lower than the calculated rating, and in certain instances this was definitely associated with poor drainage conditions.

On the basis of the data used in this analysis, it may be said that there was a definite tendency for locust height growth to be associated with the presence and amount of litter and vegetative cover, species composition, degree of erosion, and soil profile. It is evident that calculated ratings of these factors are relative and that special influences such as poor drainage, hog grazing, and fire, as well as special treatments of intensive cultivation, fertilization and mulching, may have a pronounced effect on locust height growth that may not be reflected in the calculated class rating. On the other hand, this method of analysis may be of particular value because of this fact, i.e. it may be a means of determining at least relatively, the amount of favorable or unfavorable effect these special influences exert on the height growth of black locust.

DATA FROM OTHER SAMPLE DIVISIONS

Gullies and "Galled" Spot Samples

Distribution of samples from behind dams in gully bottoms, on gully sides, hogbacks, ridges and on old field "galled" spots are shown in Table 9. It is evident that the height growth of locust has been appreciably better on soils behind gully dams than in the other locations sampled. It is also evident that fertilization on hogbacks, ridges, gully sides, and old field galled spots has been of limited value in the stimulation of good locust height growth. Study of the other data obtained in conjunction with these samples, again indicates the association of poor growth with poor drainage. Perhaps more important, however, is the recognition of the relation,

TABLE 8—COMPILATION OF INDIVIDUAL FACTOR RATINGS TO OBTAIN CALCULATED HEIGHT QUALITY CLASS FOR EACH SAMPLE ON COASTAL PLAIN SOILS, AND COMPARISON OF CALCULATED WITH ACTUAL HEIGHT QUALITY CLASS

GROUP A. - 18 Samples - No Fertilizer Added, No Special Influences.[1/]

Sample number	Factors Measured (Ratings)					Total	Calculated height quality class	Actual height quality class	Notes on associated conditions
	Profile	Erosion	Litter cover	Vegetative cover	Plant index				
47A	8.0	4.6	7.0	4.8	(7.5)	31.9	6.4	8	(See footnote Table 6)
61A	7.0	6.6	6.4	6.4	6.1	32.5	6.5	8	Colluvial
62A	5.0	4.8	6.4	6.4	6.2	28.8	5.8	7	
53B	5.0	4.8	6.4	4.8	6.1	27.1	5.4	6	
53A	7.0	6.6	6.4	6.4	5.7	32.1	6.4	6	Colluvial
51B	7.0	6.6	7.0	6.4	6.8	33.8	6.8	6	Colluvial. Phosphate very low
56B	5.0	4.8	6.4	4.8	4.7	25.7	5.1	5	Phosphate low
50C	5.0	4.8	3.0	4.0	4.6	21.4	4.3	5	
50A	5.0	4.8	5.0	6.4	4.2	25.4	5.1	5	
53C	5.0	4.8	3.0	4.8	4.1	21.7	4.3	4	
56A	5.0	4.8	3.0	4.0	(4.8)	21.6	4.3	3	Broomsedge predominant
49B	3.0	2.6	3.0	3.0	(2.7)	14.3	2.9	3	Clay at 2", plastic.
46A	2.8	4.6	3.0	3.0	3.7	17.1	3.4	3	Mottled subsoil
47B	2.8	2.6	3.0	4.8	(3.9)	17.1	3.4	3	Clay at 4", mottled, plastic.
51A	2.8	4.8	3.0	2.0	4.0	16.6	3.3	3	Sandy clay, plastic, mottled.
50B	2.8	4.6	3.0	4.8	4.8	20.0	4.0	3	Broomsedge predominant
48B	2.8	2.6	3.0	2.0	3.8	14.2	2.8	2	Mottled subsoil
61B	1.0	1.0	3.0	2.0	(3.6)	10.6	2.1	1	Subsoil at surface

[1/] These samples were used as a basis for rating litter cover, vegetative cover and erosion. Therefore a close relationship should exist between calculated and actual height quality class ratings. Samples having special influences are shown in Group D.

( ) - Based on less than 3 plant indicator species.

TABLE 8, Continued.

GROUP B. - 11 Samples- Fertilizer Added, No Special Influences

Sample number	Factors Measured (Ratings)					Total	Calculated height quality class	Actual height quality class	Conditions associated with height quality class difference.
	Profile	Erosion	Litter cover	Vegetative cover	Plant index				
34B	5.0	4.8	6.4	4.0	6.1	26.3	5.3	11	600# - 6-8-4 fertilizer
74A	7.0	6.6	3.0	6.4	5.7	28.7	5.7	11	400# 8% Phos.in beds 200# each yr. since plus manure.
38B	5.0	4.8	7.0	2.0	4.4	23.2	4.6	10	600# 4-8-4 fertilizer Watermelon patch 1st yr.
60A	7.0	6.6	6.4	6.4	5.7	32.1	6.4	10	500# 4-8-4 fertilizer
37A	7.0	6.6	7.0	4.0	5.7	30.3	6.0	9	400# 4-8-4 fertilizer
40A	7.0	6.6	7.0	4.0	5.7	30.3	6.0	8	400# 4-8-4 fertilizer
38A	5.0	4.6	3.0	4.8	4.5	21.9	4.4	8	600# 4-8-4 fertilizer
74B	5.0	2.6	6.4	4.0	6.1	24.1	4.8	6	Phos. in beds and since planting, manure, intensive cultivation.
38C	5.0	4.6	3.0	4.0	4.4	21.0	4.2	4	Active erosion, beds washed out, 600# -4-8-4 fertilizer
40B	5.0	6.6	3.0	6.4	4.9	25.9	5.2	4	400# 4-8-4 fertilizer 8" of plus material, but subsoil very compact at 10" below ground surface.
36A	5.0	4.6	3.0	6.4	4.4	23.4	4.7	3	600# 6-8-4 fertilizer; broomsedge very heavy.

TABLE 8, Continued.

GROUP C. - 6 Samples having Manure and/or Lime Added, No Special Influences.

Sample number	Factors Measured (Ratings)					Total	Calculated height quality class	Actual height quality class	Conditions associated with height quality class differences.
	Profile	Erosion	Litter cover	Vegetative cover	Plant index				
57B	5.0	4.8	3.0	4.0	5.9	22.7	4.5	6	1 ton of lime and 1 ton of manure per A.
57C	5.0	4.8	3.0	4.0	(5.3)	22.1	4.4	6	1 ton of lime and 1 ton of manure per A.
57A	5.0	4.8	3.0	2.0	(3.9)	18.7	3.7	3	1 ton of line and 1 ton of manure per A., but poor drainage.
55B	5.0	4.8	7.0	6.4	(4.5)	27.7	5.5	7	Barnyard manure
58A	5.0	4.6	3.0	2.0	(4.4)	19.0	3.8	6	Barnyard manure
62B	5.0	4.8	3.0	4.0	5.1	21.9	4.4	5	1/2 ton lime per acre

( ) - Based on less than 3 plant indicator species.

Fig. 4 – Comparison of calculated with actual locust height quality class ratings for 56 Coastal Plain samples

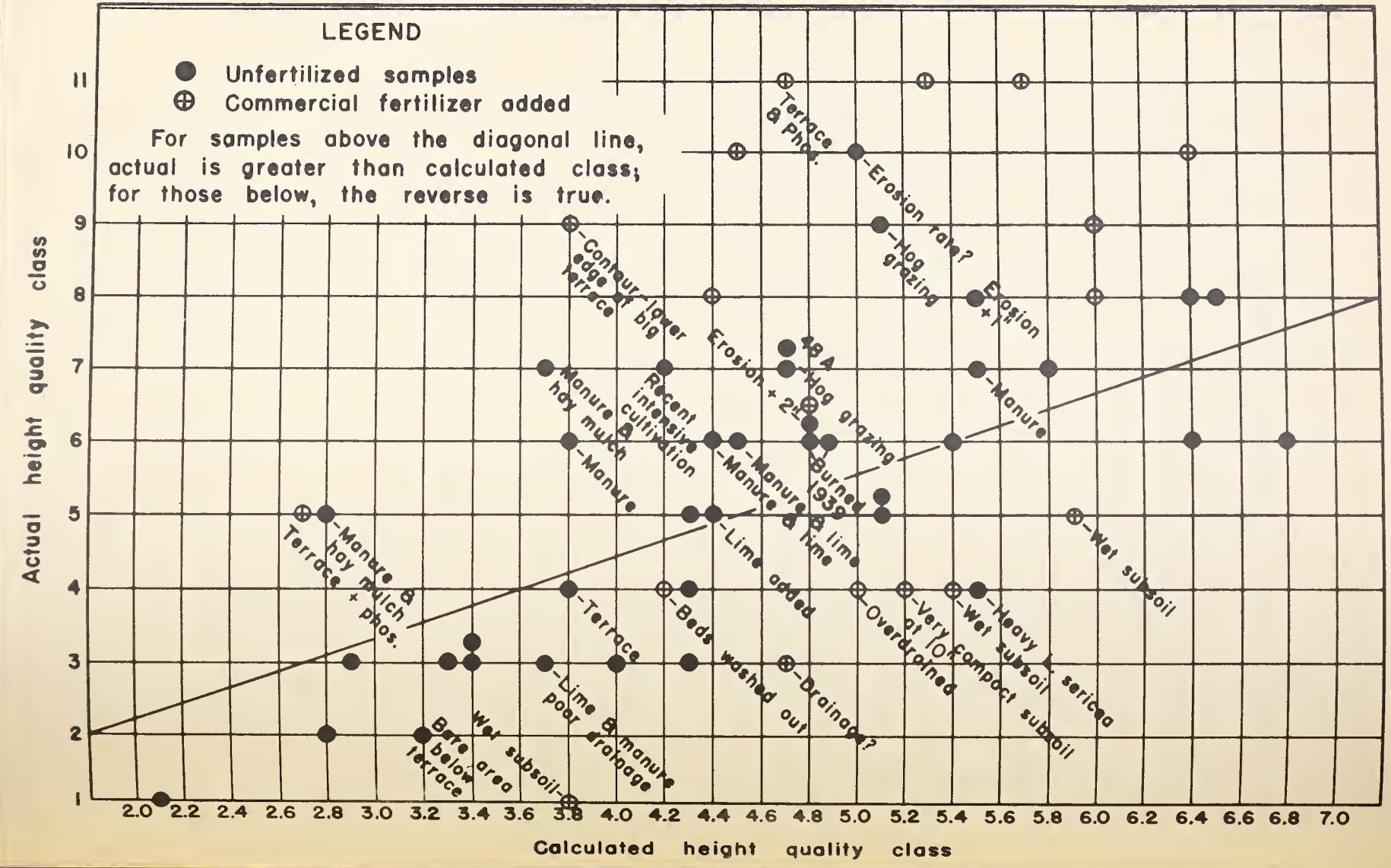


TABLE 9.--DISTRIBUTION OF SAMPLES FROM GULLIES AND GALLED SPOTS MAINLY ON PIEDMONT SOILS.
(According to locust height quality class)

Height quality class	Field type							
	Old field gall spots		Gully sides, hogbacks, ridges		Gully bottoms behind dams			
	* A	* B	A	B	A	B		
11					2			
10					1			
9								
8					2			
7					2			
6		1						
5				3	1	1		
4	1		1	3	1			
3		1		2	1			
2	3	2						
1	1							
Weighted class averages	2.2	3.2	4.0	4.1	7.4	5.0		

* A - Unfertilized samples.
* B - Fertilized samples.

ERRATA SHEET

"A METHOD FOR JUDGING QUALITY OF PLANTING SITES FOR BLACK LOCUST BASED ON FIELD CLINIC DATA" - SCS-TP-34, July 1940

CHANGE:

PAGE 9, 4TH LINE UNDER "PIEDMONT SAMPLES" TO:

In general, poor locust growth occurred on severely eroded soils having a shallow surface layer and a compact subsoil.

in these extreme conditions, between lack of litter and vegetative cover and the occurrence of poor locust growth. It would seem that poor locust growth is here associated first with soil conditions unfavorable for moisture reception and penetration, and second with low soil fertility. Attempts to correct conditions in these spots or areas should take into consideration not only the initial establishment, but also the maintenance of favorable conditions.

Piedmont Samples

The samples from the Piedmont soils were taken first and aided in perfecting the method of sampling. They do not allow for as detailed analysis as carried out on the Coastal Plain soils, however, they do indicate certain trends. In general, good locust growth occurred on severely eroded soils having a shallow surface layer and a compact subsoil. Continued active erosion appears to be detrimental to locust height growth. The presence of an abundance of litter cover and plant cover was usually associated with good locust growth. However, it was observed that where the heavy vegetative cover was predominantly broomsedge, the locust growth was generally poor.

Alabama Black Belt Samples

Only limited observations were made in this area and the plantations visited were only in their second year since establishment. In general, the best locust growth was observed in places where the topsoil layer was present, where the plants had been placed in 4 furrow beds, where phosphate had been added and the plantation cultivated. It would seem that in this Black Belt area, measurement of the drainage conditions would be important in judging potential locust sites. Also, on the basis of general information obtained, it would appear that the addition of phosphate is highly desirable. Although black locust planted on Sumpter clay was seen to have survived and made some growth, the desirability of considering such spots for locust post production is questionable.

Loessial Samples

In general, the best black locust growth was found in areas where erosion had been slight and organic matter was still incorporated in the topsoil, and where a litter and vegetative cover were present. In the Memphis and Loring soil series where the silt loam was of considerable depth, the loss of the topsoil as indicated by the occurrence of erosion 2 and 3, was frequently accompanied by a marked reduction in locust height growth.

DISCUSSION

In any attempt to judge the factors influencing the growth response of a plant in the field, measurements of soil moisture and nutrients would be very desirable. Unfortunately, there are no rapid means of obtaining accurate measures of these complicated and ever changing factors. However, it seems both plausible and possible to obtain a relative means of estimating site values for a given species when systematic field observations are made of conditions associated with the variations in growth of that species. These observations should also serve as an indication of the relative importance of the factors or groups of factors in limiting or favoring growth of the species.

In the present study of black locust, it was essential to list the factors to be measured. Results of studies by previous investigators (Auten and others) have shown the necessity of measuring soil conditions. Thus, the observations and measures taken have been centered around the points at which soil borings were made. The recording of erosion, site treatment, fertilization, cultivation, slope, litter cover, vegetative cover, and planting type was done chiefly because of the interest of the Soil Conservation Service in these factors in relation to erosion control and post patch plantings or black locust. The measurement of locust growth could have been made in several ways, but height was selected as the basic measure because it was easy to obtain and because it gave a measure that indicated in a general way the value of the plantings for production of post material.

The analysis of the data collected has resulted in the association of certain measurements with locust height growth response. The value of these measures should be tested by collection of further data. However, the associations established on the basis of the data at hand are of sufficient interest to warrant summary and discussion.

Soil Profile as a Measure of Locust Site Quality

Soil profile measurements are of particular value in affording a means of identifying the very poorly and excessively drained areas which should not be planted to black locust. Dr. Auten has published descriptions of subsoil conditions associated with poor locust growth so that field technicians should be able to obtain at least a relative concept of soil plasticity, compaction, and mottling accompanying poor drainage conditions.

Soil profile measurements should also distinguish the soils in which there are no obvious signs of very inadequate drainage. However, on the basis of the present study on old fields, soils with

adequate drainage did not always produce good locust growth, therefore measures of other factors are necessary for judging locust site quality.

EROSION AS AN INDICATOR OF LOCUST SITE QUALITY

"Erosion plus," as exemplified by deep well drained colluvial soils, was found to be favorable for locust height growth as also were deep friable soil deposits behind gully dams.

> Erosion 1, 2, or 3 was related to both good and poor locust height growths on Coastal Plain soils.
>
> Erosion 4 or 5 was definitely associated with poor locust growth on Coastal Plain soils.

In this study it was observed that the continuance of erosion following planting appeared to be a reliable indication of conditions detrimental to the height growth of black locust. One might attribute the detrimental influences to such things as continued loss of topsoil, organic matter, and microflora or the development of a hard ground surface, unfavorable to the reception and penetration of moisture, as important limiting factors. With recognition of the detrimental influence of such conditions, it then logically follows that site selection and preparation and means of site improvement must include consideration of means of stopping or greatly reducing active erosion. Such considerations apply especially to areas where the planting objective is primarily concerned with the production of post material.

DENSITY OF LITTER COVER AS AN INDEX OF LOCUST SITE QUALITY

In general, the greater the amount of litter cover present in a locust plantation the better was the locust height growth. This is understandable in view of the results of studies by Dr. Peele which point out the reduction in run-off in relation to mulch. Benefits from mulches as mentioned by Franklin in USDA Leaflet 190, include:

1. Retards moisture evaporation
2. Improves conditions to absorb water
3. Reduces transpiration
4. Reduces movement of soil particles and builds up deposits favorable for planting

5. Acts as an indirect fertilizing agent

6. Reduces danger of damage by frost heaving.

The value of litter cover as a means of judging site quality prior to planting is not definitely known, but measures of the amount of litter cover following plantation establishment appear to be a valuable index of the presence of favorable or unfavorable conditions. This has served to emphasize the possible value of mulching as one means for betterment of sites where unsatisfactory locust growth has occurred. The indicated value of mulching in relation to locust growth seems apparent, but the methods, materials and their application should be the subject of further study.

VEGETATIVE COVER AS AN INDEX OF LOCUST SITE QUALITY

The present study has indicated that density of plant cover is one important means of judging site quality for locust growth. In the old field locust plantings light plant cover was usually accompanied by poor locust growth except where the light cover was the result of suppression by the dense growth of locust. A medium plant cover usually accompanied good locust growth. Frequently a heavy plant cover was also associated with good locust growth. However, a heavy plant cover composed solely or predominantly of broomsedge was generally accompanied by poor locust growth.

The plant species composing the vegetative cover appear to be definitely related to locust growth response. It is recognized that results of the present study are based on a relatively small number of samples and are limited to the Coastal Plain soils, however, the principles established by this analysis appear to be sound and it is possible to employ the method developed for the study of locust growth in relation to plant species on any individual or group of soils or areas.

SPECIAL INFLUENCES ON INDICES OF LOCUST SITE QUALITY

It must be kept clearly in mind that indices other than soil profile do not apply where very poor drainage conditions are present.

Indexes based on litter cover, vegetative cover and plant species are relative and subject to man-made influences. Such things as fire, hog grazing, and recent cultivation affect these indices. Samples taken under such conditions were of necessity considered separately in the present study. It also was indicated by data in this study that shallow deposits of soil (erosion plus) could have an influence on the litter cover rating.

VALUE OF COMBINED INDICES FOR JUDGING LOCUST SITES

Any tree planting program on old fields is of necessity forced to deal with the result of man's misuse of land. The conditions existing on such lands may vary greatly. Differences in growth of black locust planted on old fields have been related to certain measurements. The results of analysis of observations reported in this study indicate that there are many factors involved, but that by the measurement of soil profile, sheet erosion, litter cover, plant cover and species composition, a relative estimate of conditions favorable or unfavorable for black locust growth may be obtained.

The results of this study also indicate that taking of soil profiles is the best means of identifying unsatisfactory black locust sites due to very poor internal drainage. In all other locations, however, the combined use of all measures listed is more satisfactory than the use of any single measure for judging site quality.

The method as here developed is based on and allows for the rating of spots or small areas in a given field. The determination of whether an entire field or only a portion of it should be planted for the purpose of locust post production would then depend on the size, frequency and distribution of the favorable and unfavorable spots or areas.

Obviously, this study is only a beginning, its chief value being the introduction of a method for relating several physical measurements to growth response of a tree species. It is sincerely hoped that the reader may find the time and patience to test its validity in relation to black locust and other tree species and expand its usefulness by application of the method to the soil province or local conditions with which he is working.

"BLACK LOCUST CLINIC" - field trip Sept.-Oct., 1939

Date (1939)	City	Towns visited in Vicinity	State	Field Party	Field (figures) and Sample (letters)numbers.
9/25 9/26	High Point	Idoll Gully Colfax		Lauderburn, Mullen, Watts, Howland, Posey, Hartley, Fivaz, Hopp, Grant	1A to 3A, 4A to 4K, 5A to 5D, inc.
9/27	Durham	Burlington, Duke Forest	N.C.	Lauderburn, Watts, Beal, Howland. Coile, Korstian, Posey, Fivaz, Hopp, Grant	6A, 7A to 12B, inclusive
9/28		Franklinton, Wake Forest		Eagles, Watts, Howland, Massey, Fieman, Morgan, Posey, Fivaz, Grant	13A to 13E, 14A to 14I, inc.
9/29	Wadesboro	Hoffman, Polkton, Peachland		Lauderburn, Peele, Fetzer, Hagge, Pleasants, Posey, Fivaz, Grant, Howland, Robinson	15A to 15D, 16A to 18A, inc.
				Lauderburn, Peele, Fetzer, Hagge, Pleasants, Posey, Fivaz, Grant	19A to 19D, 20A to 21B, inc.
9/30	Spartanburg	Greer, Riedville		Lauderburn, Peele, Posey, Fivaz, Grant	22A to 22D, 23A & B, inc.
10/5	Clemson	Poplar Springs, Liberty, Walhalla	S.C.	Lauderburn, Peele, Posey, Fivaz, Grant	24A - B - C
				Grant	25 A - B
				Peele, McGee, Mollianardi, Grant	26A & B, 27C, inc.
10/6	Gainesville	Athens	Ga.	Galloway, Brown, Knight, Beale, Posey, Grant	28A & B, 29 A-B-C
10/7	La Grange			Brown, Knight, Posey, Grant, (Re-samples by Flory & Bohleber)	30A to 33C, inclusive (32 A-B-C-D)
10/9	Greenville			Prout, Ritchie, Aldridge, Cole, Posey, Grant	34A to 40B, inc.
10/10	Newbern	Greensboro	Ala.	Sebring, Prout, Ritchie, Morgan, Jones, Posey, Grant	41A to 44B, inc.
		Mckenzie		Prout, Ritchie	73A to 74B, inc.

Date (1939)	City	Towns visited in Vicinity	State	Field Party	Field (figures) and Sample (letters) numbers.
10/11	Meridian	Pine Springs		Sebring, Nall, Havens, Posey, Grant	45A to 46A, 51A to 53D, inc.
10/12	Collins	Laurel, Taylorsville	Miss.	Sebring, Thompson, Bishop, Wells, Posey, Grant	55A to 63A, inc.
10/13	Port Ginson	Canton		Post, Herring, Posey, Grant	64A to 72B, inc.